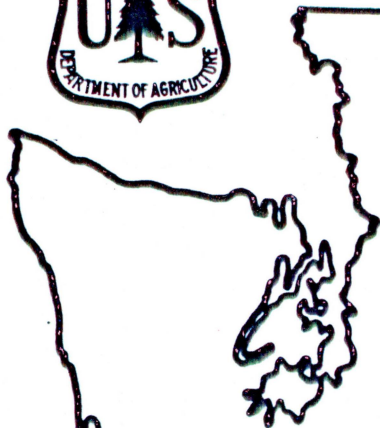
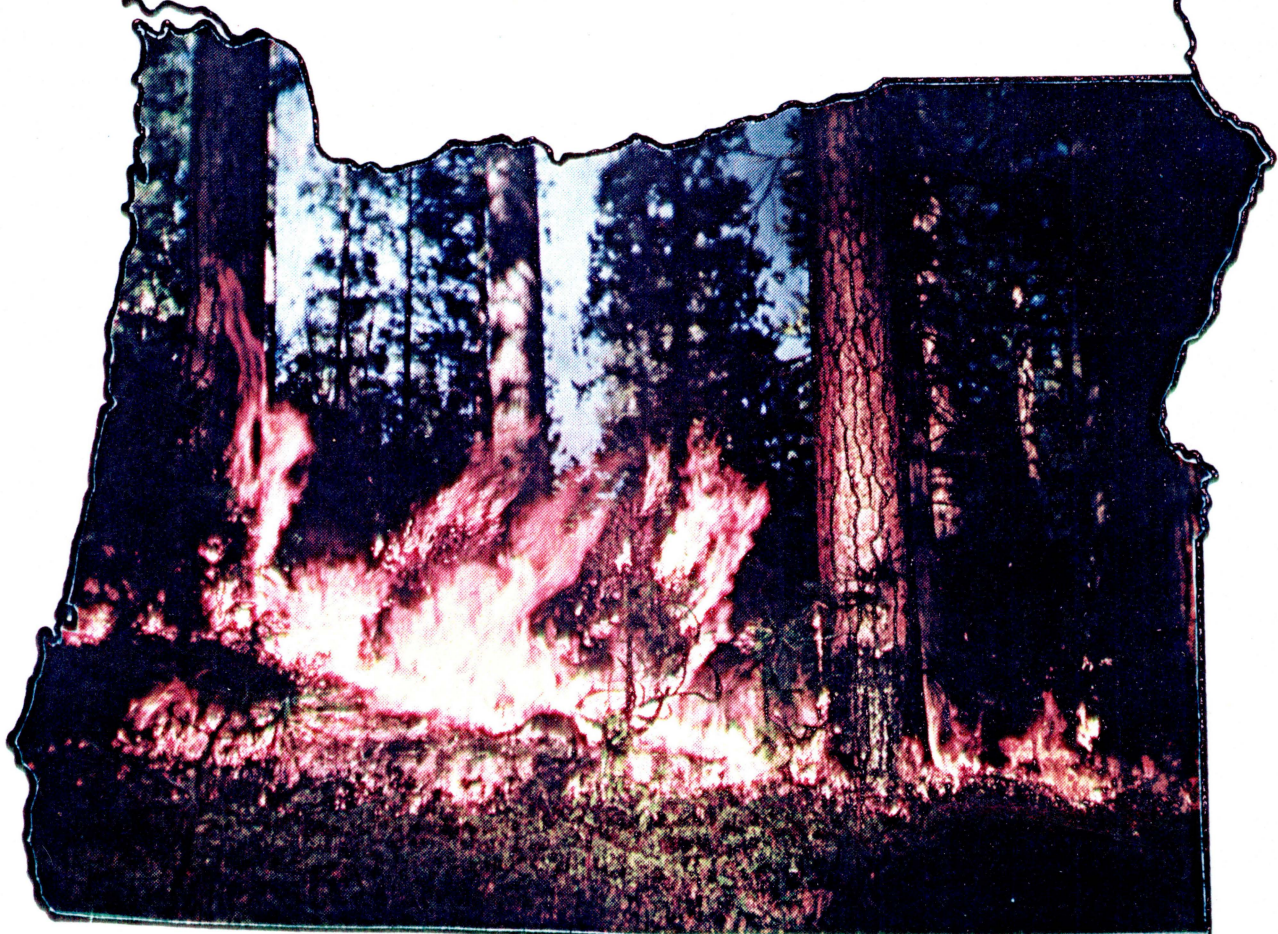


Forest Pest Management

Pacific Northwest Region



INJURIES AND POTENTIAL DECAY LOSSES
IN UNDERBURNED WHITE FIR ON THE
FREMONT NATIONAL FOREST



Injuries and Potential Decay Losses in Underburned
White Fir on the Fremont National Forest

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In recent years, the Fremont National Forest has had an active prescribed burning program. Most of this controlled burning has been done in stands dominated by ponderosa pine with the aim of reducing fuel loads and favoring the fire-tolerant pines over less fire-resistant competing vegetation. White firs, also components of some underburned stands, are frequently killed by hot fires. Many, however, survive less intense burns. When they are not killed, the thin-barked white firs may be injured by heat, and wounded white firs have the potential to become substantially decayed over time. Silviculturists are interested in knowing how much loss to expect in underburned white fir stands. Forest Managers also want to determine whether underburning white fir stands or retaining injured firs that have survived prescribed burning in mixed stands are good practices. The present evaluation was done to provide information on: (1) the amount of injury to white fir crop trees in a sample of underburned stands on the Fremont National Forest, and (2) the current and future amount of decay associated with injuries on such trees.

METHODS

Locations and histories of six stands that had been underburned between 1962 and 1982 and contained varying levels of white fir stocking were obtained from the Fremont National Forest Fire Staff. Each stand was sampled with 20 variable plots (BAF 40) defined with a Spiegel-Relaskop along a systematic 2 x 5 chain grid. All plot trees were tallied, and the following information was recorded for each: species, DBH, general condition, presence and size of fire-scorched areas on stem, presence and size of open wounds, and presence and extent of dead cambium under loosened bark. From the data collected in the variable plots, mean number of trees and basal area per acre were tabulated by tree species, DBH class, and condition. Also, percent of trees with wounds was calculated.

In four of the surveyed stands, a sample of white firs was felled and dissected. Trees selected were the closest crop trees (6 inches DBH or greater) to the stand exam plot centers of the first 15 points. The following information was collected for each felled tree: total age; DBH; total height; height to the bottom of the live crown; height to the 4-inch top; length of the last 10-years terminal growth; mean radial growth for last 10 years at breast height; mean stump diameter inside bark; mean diameter inside bark at the top of the first 16-foot log; mean diameter inside bark at the 4-inch top; diameter and length of wetwood column; height on stem, width, length, age, and cause (if determinable) of each wound; and diameter and length of each decay column. Decay included both incipient (stain) and advanced decay. Data collected were used to determine actual amount of decay currently present in

sampled white firs expressed as a percentage of total white fir volume. Also, projections were made of potential volume losses to be expected at time of final harvest by employing the decay expansion rates determined by Filip et. al.*

RESULTS AND DISCUSSION

Incidence of Wounding - White firs in underburned stands exhibited a high incidence of wounding. Sixty-five percent of all firs in sampled stands had wounds vs. 23 percent for ponderosa pine. Percentage of live firs wounded in individual stands ranged from 45 to 76 and for pine, 0 to 39 (Tables 1-7). Open wounds accounted for 78 percent of the injuries observed on the firs. Just over half of these (58 percent) were the result of mechanical injuries sustained before the prescribed burning. Many were increased in size and depth by the fire. The other 42 percent of open wounds was caused by burning alone and occurred where heavy fuel had burned in close proximity to fir stems. In addition to open wounds, hidden injuries involving patches of killed cambium under scorched but still-intact bark were fairly common (Figures 1 and 2). These accounted for 22 percent of all wounds. Removing scorched bark or totally dissecting stems was necessary to detect these wounds.

Current and Projected Amounts of Stain and Decay - Dissection showed that columns of stained and decayed wood were associated with virtually all wounds, even those created only 2 years prior to examination. The latter, however, tended to be rather small. Current cubic foot volume affected averaged 3.6 percent of the total white fir volume (approximately 9 percent of the board foot volume) for all stands. Percentage of cubic foot volume stained or decayed in individual stands (Table 1) ranged from 0.8 to 8.2 (approximately 2 to 20 percent of the board foot volume).

Stain and decay columns were compartmentalized. There was no indication that they developed radially into wood laid down after wounding. There was, however, evidence of rapid vertical expansion within the portion of the stem that was present before the wounds were created. Since white firs in the surveyed stands were fairly large at the time of burning (average DBH was 12 inches), trees were relatively old (average age was 76 years), and radial growth rates were rather slow (average just under .5 inch for the last decade), decay development should exceed amount of additional wood produced on

* Filip, Gregory M., Paul E. Aho, and Marc R. Wiitala. 1983.

Indian paint fungus: a method of recognizing and reducing hazard in advanced grand and white fir regeneration in eastern Oregon and Washington. Pacific Northwest Region. USDA Forest Service. 18 p.

wounded firs in the next 30 to 80 years. Projections of amounts of stained and decayed wood at harvest ages of 110 and 150 years* reflect this (Table 1). At 110 years, they averaged 7.7 percent of the cubic foot volume (approximately 19 percent of the board foot volume) for all stands and ranged from 3.8 to 15.4 percent of the cubic foot volume (approximately 9 to 37 percent of the board foot volume) in individual sampled stands. At 150 years, they averaged 13.7 percent of the cubic foot volume (approximately 33 percent of the board foot volume) for all stands and ranged from 6.7 to 27.1 percent of the cubic foot volume (approximately 16 to 65 percent of the board foot volume) in individual sample stands.

Organisms Involved in Causing Stain and Decay - Fungi involved in causing stain and decay of white fir in underburned stands fell into three groups: wound colonizers, suppressed tree branchlet colonizers, and root disease fungi. Representatives of each were common in surveyed stands.

Wound colonizing fungi include Pholiota limonella, Amylostereum chailletii, Haematostereum sanguinolentum, Fomitopsis pinicola, Hericiium abietis, Sistotrema sp., and several unidentified hymenomycetes. These fungi infect hosts by means of windborne spores released from mushrooms or conks. Spores land on freshly created wounds, germinate, and colonize the wood behind the wound. Infection can occur through any kind of open wound. However, especially severe decay is associated with large wounds in contact with the soil.

The major suppressed tree branchlet colonizer is Echinodontium tinctorium, the Indian paint fungus. This fungus also spreads by windborne spores released from conks, but infection occurs through small (less than 2mm diameter) exposed branchlet stubs rather than through wounds. Most infection courts occur on understory trees that have been suppressed for at least 40 years. Once E. tinctorium has successfully colonized a branchlet stub and the stub is overgrown by the tree, the fungus enters a dormant state. Chlamydospores are formed that can survive for many years without causing decay. Dormant infections are activated to produce decay columns when wounds are created within one foot of the resting spores. Especially large decay columns develop when several dormant infections are activated at the same time. Losses caused by Indian paint fungus are greatest in severely wounded, released white-fir understories on north facing slopes.

Root disease fungi include Armillaria mellea and Fomes annosus. In addition to causing stain and decay, these fungi frequently cause tree mortality. A. mellea infects trees vegetatively by underground spread of mycelium across root contacts and grafts. Aerial infection by spores is negligible, hence, wounds are not necessary for infection. However, A. mellea is most successful at colonizing stressed trees, and therefore, wounding may increase susceptibility. F. annosus spreads by windborne spores and infects freshly created wounds or stumps. Once it has colonized a tree or stump, it is capable of spreading to adjacent trees via root contacts.

*Rotation ages employed in "Fremont National Forest Yields for Managed Stands" J. R. Nesbitt. 1982.

In addition to stain and decay caused by fungi, all wounded trees that were dissected in this survey exhibited substantial amounts of wet wood. The exact cause of wet wood is not known, but it has been attributed to bacterial infection, tree wound response, or normal age-growth formation. Wetwood does not develop into decay but it can contribute to shake, collapse, and ring failure. Warpage results and longer drying rates are required for boards produced from affected wood.

MANAGEMENT RECOMMENDATIONS

Results of our survey show that underburned white firs on the Fremont National Forest sustain substantial amounts of injury that can lead to severe decay losses. Based on these results, we suggest the following specific recommendations.:

1. In white fir dominated stands where continued management of white fir is desired, prescribed burning should not be done.
2. In mixed stands, prescribed burning will be a viable tool mainly if species other than white fir make up a substantial portion of the stocking and are preferred for management. Recognize that if prescribed burning is done, losses comparable to those reported in this evaluation can be expected in the white fir component.
3. In stands with white fir components that have already been underburned, recognize that decay losses increase with time after wounding. Thus, early harvest or selective removal of white fir during commercial thinnings may minimize losses.
4. Wounds to residual trees, especially white fir, can and should be prevented in all management activities because of the potential losses due to decay and other defects associated with injuries. Actions can be taken both in the planning process and in the actual operation to minimize damage.



Figure 1.--Underburned white fir on the Fremont National Forest. Note extensive scorching.



Figure 2.--Typical hidden injury occurring under scorched bark on white fir. This type of wound is not evident until bark is removed.

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Table 1: Incidence of wounding and current and projected amounts of stain and decay in white fir in stands surveyed on the Fremont National Forest.

Stand No.	Location	Year Burned	% Total Stocking Composed of W.F.	% W.F. Wounded	% W.F. Vol. Currently Stained or Decayed <u>1/</u>	Projected % W.F. Vol. Stained or decayed at harvest			
						110 yr. rotation age <u>2/</u>	150 yr. rotation age <u>2/</u>		
				Age	Aspect				
1	Camas Prairie T. 39 S., R. 32 E., sec. 9	1981	65	76	61	W	2.8 (7) <u>3/</u>	4.9 (12)	8.6 (21)
2	Dairy Creek T. 35 S., R. 16 E., sec. 23 & 24	1962	49	71	51	S	3.0 (7)	6.6 (16)	11.7 (28)
3	Black Hills T. 34 S., R. 14 E., sec. 19 & 20	1976	84	78	81	N	8.2 (20)	15.4 (37)	27.1 (65)
4	Burnt Creek T. 40S., R. 32 E., sec. 1	1982	96	69	73	S	4.1 (10)	9.7 (23)	17.1 (41)
5	Horseglade T. 34 S., R. 14 E., sec. 24 T. 34 S., R. 14 1/2, E., sec. 19	1982	3	-	45	S	0.8 (2)	3.8 (9)	6.7 (16)
6	Cove Creek T. 39 S., R. 17 E., sec. 7 & 8	1982	42	-	80	E	2.8 (7)	6.1 (15)	10.8 (26)

1/ Based on tree dissection and actual measurement

2/ Based on equations developed by Flip et al.

3/ First number is cubic foot volume, number in parentheses is approximate board foot volume (Scribner).

Table 2: Number of trees and ft.² basal area (in parentheses) per acre by diameter class, species, and condition for surveyed stand 1, Camas Prairie.

DBH Class (inches)	White Fir			Ponderosa Pine		
	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead
6						
8						
10	7.33 (4.0)	7.33 (4.0)		3.67 (2.0)	3.67 (2.0)	
12	7.64 (6.0)	2.55 (2.0)	5.09 (4.0)	2.55 (2.0)	2.55 (2.0)	
14	3.74 (4.0)	7.48 (8.0)	1.87 (2.0)	1.87 (2.0)		
16	4.30 (6.0)	12.89 (18.0)		10.03 (14.0)		
18	1.13 (2.0)	2.26 (4.0)		2.26 (4.0)	2.26 (4.0)	1.13 (2.0)
20	0.92 (2.0)			1.83 (4.0)		
22				1.52 (4.0)		
24			0.64 (2.0)	0.64 (2.0)		
26				0.54 (2.0)	0.54 (2.0)	
28	0.47 (2.0)	0.47 (2.0)		0.47 (2.0)		
30						
32				0.72 (4.0)		
34						
36						
38						
40	0.23 (2.0)					
42	0.21 (2.0)					
44						
46		0.17 (2.0)	0.17 (2.0)			
48						
50						
52	0.14 (2.0)					
54						
All Classes	26.11 (32.0)	33.15 (40.0)	7.79 (10.0)	26.10 (42.0)	9.02 (10.0)	1.13 (2.0)
Percent	39 (39)	49 (49)	12 (12)	72 (78)	25 (18)	3 (4)

Table 3: Number of trees and ft² basal area (in parentheses) per acre by diameter class, species, and condition for surveyed stand 2, Dairy Creek.

DBH Class (inches)	White Fir			Ponderosa Pine			Lodgepole Pine		
	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead
6	20.37 (4.0)	40.74 (8.0)		10.19 (2.0)	20.37 (4.0)		20.37 (4.0)		
8	22.92 (8.0)	11.46 (4.0)		17.19 (2.0)	5.73 (2.0)		11.46 (4.0)	5.73 (2.0)	5.73 (2.0)
10	14.67 (8.0)	18.33 (10.0)		11.00 (6.0)	3.67 (2.0)		11.00 (6.0)		
12	15.28 (12.0)	5.09 (4.0)		7.64 (6.0)				5.09 (2.0)	
14				1.87 (2.0)	1.87 (2.0)		1.87 (2.0)		
16	1.83 (2.0)	1.83 (2.0)		2.86 (4.0)	1.43 (2.0)				
18				1.13 (2.0)	2.26 (4.0)				
20		0.92 (2.0)							
22				1.52 (4.0)	0.76 (2.0)	0.76 (2.0)			
24				1.27 (4.0)					
26	0.54 (2.0)			1.63 (6.0)	0.54 (2.0)				
28				1.40 (6.0)	0.94 (4.0)	0.94 (4.0)			
30		0.41 (2.0)			0.81 (4.0)	0.81 (4.0)			
32				0.36 (2.0)	0.72 (4.0)	0.36 (2.0)			
34					0.32 (2.0)	0.32 (2.0)			
36				0.28 (2.0)					
38			0.25 (2.0)	0.25 (2.0)		0.25 (2.0)			
40		0.23 (2.0)		0.23 (2.0)	0.23 (2.0)				
42						0.21 (2.0)			
44		0.19 (2.0)							
46		0.17 (2.0)							
All Classes	75.61 (36.0)	79.37 (38.0)	0.25 (2.0)	58.82 (56.0)	39.65 (36.0)	3.65 (18.0)	44.70 (16.0)	10.82 (6.0)	5.73 (2.0)
Percent	49 (48)	51 (50)	1 (2)	58 (51)	39 (33)	3 (16)	73 (67)	18 (25)	9 (8)

*Windthrown

Table 4: Number of trees and ft.² basal area (in parentheses) per acre by diameter class, species, and condition for surveyed stand 3, Black Hills.

DBH Class (inches)	White Fir			Ponderosa Pine			Sugar Pine		
	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead
6	10.19 (2.0)								
8		28.65 (10.0)	11.46 (4.0)						
10		3.67 (2.0)	7.33 (4.0)						
12	2.55 (2.0)	2.55 (2.0)							
14		1.87 (2.0)		1.87 (2.0)					
16					1.43 (2.0)				
18								1.13 (2.0)	
20				0.92 (2.0)					
22								1.52 (4.0)	
24	0.64 (2.0)								
26					0.54 (2.0)			0.54 (2.0)	0.54 (2.0)
28				0.47 (2.0)				0.47 (2.0)	
30				0.41 (2.0)	0.41 (2.0)		0.41 (2.0)		
32				0.32 (2.0)				0.72 (4.0)	
34		0.32 (2.0)		0.57 (4.0)				0.32 (2.0)	
36			0.28 (2.0)						
38								0.25 (2.0)	
40									
42									
44						0.38 (4.0)			
All Classes	13.38 (6.0)	37.06 (18.0)	19.07 (10.0)	4.49 (14.0)	2.38 (6.0)	0.00 (0.0)	0.79 (6.0)	4.95 (18.0)	0.54 (2.0)
Percent	19 (18)	53 (53)	28 (29)	65 (70)	35 (30)	0 (0)	13 (23)	79 (69)	8 (8)

Table 5: Number of trees and ft.² basal area (in parentheses) per acre by diameter class, species, and condition for surveyed stand 4, Burnt Creek.

DBH Class (inches)	White Fir			Ponderosa Pine		
	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead
6	5.73 (2.0)	28.65 (10.0)				
8	18.33 (10.0)	40.34 (22.0)				3.67 (2.0)
10	5.09 (4.0)	7.64 (6.0)				
14	1.87 (2.0)	7.48 (8.0)				
16	1.43 (2.0)	2.86 (4.0)				
18						
20						
22						
24				0.64 (2.0)		
26						
28						
30				0.41 (2.0)		
32						
34						
36						
38						
40				0.23 (2.0)		
All Classes	32.45 (20.0)	86.97 (50.0)	0.00 (0.0)	1.28 (6.0)	0.00 (0.0)	3.67 (2.0)
Percent	27 (29)	73 (71)	0 (0)	26 (75)	0 (0)	74 (75)

Table 6: Number of trees and ft.² basal area (in parentheses) per acre by diameter class, species, and condition for surveyed stand 5, Horseglade.

DBH Class (inches)	White Fir			Ponderosa Pine			Lodgepole Pine		
	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead
6				40.74 (8.0)	5.09 (1.0)		5.09 (1.0)		
8				31.51 (11.0)	2.86 (1.0)	5.72 (2.0)			
10		1.83 (1.0)		12.83 (7.0)	1.83 (1.0)				
12	1.27 (1.0)			6.37 (5.0)	1.27 (1.0)				
14	0.94 (1.0)			2.81 (3.0)					
16									
18				1.70 (3.0)					
20				0.92 (2.0)					
22				1.52 (4.0)					
24				1.91 (6.0)					
26					0.27 (1.0)				
28				0.23 (1.0)	0.46 (2.0)				
30				0.61 (3.0)					
32					0.36 (2.0)				
34									
36				0.28 (2.0)					
All Classes	2.21 (2.0)	1.83 (1.0)	0.00 (0.0)	101.43 (55.0)	12.14 (9.0)	5.72 (2.0)	5.09 (1.0)	0.00 (0.0)	0.0 (0.0)
Percent	55 (67)	45 (33)	0 (0)	85 (83)	10 (14)	5 (3)	100 (100)	0 (0)	0 (0)

Table 7: Number of trees and ft.² basal area (in parentheses) per acre by diameter class, species, and condition for surveyed stand 6, Cove Creek.

DBH Class (inches)	White Fir			Ponderosa Pine			Incense Cedar		
	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead	Live Unwounded	Live Wounded	Dead
10.19 (2.0)	6					10.19 (2.0)	10.19 (2.0)	10.19 (2.0)	
10	8	11.46 (8.0)	34.38 (12.0)		5.73 (2.0)		5.73 (2.0)	5.73 (2.0)	
12	3.67 (2.0)	29.34 (16.0)		25.67 (14.0)	7.33 (4.0)		3.67 (2.0)	7.33 (4.0)	
14	5.09 (4.0)	2.55 (2.0)	2.55 (2.0)	17.83 (14.0)	2.55 (2.0)			2.55 (2.0)	
16	1.43 (2.0)	14.97 (16.0)	1.87 (2.0)	9.35 (10.0)	1.87 (2.0)	1.87 (2.0)	1.87 (2.0)		
18		1.13 (2.0)		5.73 (2.0)	1.43 (2.0)				
20				1.13 (2.0)	2.26 (4.0)				
22				0.92 (2.0)					
				0.76 (2.0)			0.76 (2.0)		
All Classes	21.65 (12.0)	82.87 (48.0)	4.42 (4.0)	67.12 (54.0)	25.63 (16.0)	17.79 (6.0)	21.46 (8.0)	10.64 (8.0)	10.19 (2.0)
Percent	20 (19)	76 (75)	4 (6)	61 (71)	23 (21)	16 (8)	51 (44)	25 (44)	24 (12)